DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to a surface acoustic wave apparatus and its frequency characteristic adjustment methods, such as a surface acoustic wave filter.
[0002]
[Description of the Prior Art]A surface acoustic wave apparatus is based on an electrical signal, and is generally a surface acoustic wave (below Surface Acoustic Wave;.). SAW -- saying -- it has a transducer (below Interdigital Transducer; calls it IDT) of the shape of a blind for exciting. By processing to the IDT, the various characteristics and functions in a surface acoustic wave apparatus are brought about. When calling it the surface acoustic wave apparatus conventionally, the surface acoustic wave filter was mainly shown, but many surface acoustic wave resonators also come to be used now, and the range of a surface acoustic wave apparatus is also large. In addition, since the surface acoustic wave convolver also has IDT, it is one of the surface acoustic wave apparatus. Drawing 2 is structural drawing showing the conventional surface acoustic wave apparatus.
The surface acoustic wave resonator is shown as an example.
This surface acoustic wave resonator has the piezoelectric boards 1, such as $LiTaO_3$ and $LiNbO_3$. On the piezoelectric board 1, the underlay 2 of the thin film which makes aluminum or aluminum the charge of a principal member is formed, and the input terminal 3 and the output terminal 4 are formed on the underlay 2. The input terminal 3 and the output terminal 4 are the bonding pads of a golden thin film. The input terminal 3 and the output terminal 4 are connected to IDT5 for SAW excitation via the underlay 2, respectively. IDT5 comprises the electrode finger 5a connected to the input terminal 3, and the electrode finger 5b connected to the output terminal 4. IDT5 is produced simultaneously with the underlay 2 and the thickness and construction material of the IDT5 are the same as the underlay 2. The antenna reflector 6

is formed in the both sides of IDT5. The antenna reflector 6 is also produced simultaneously with IDT5, and that of the thickness and construction material of the antenna reflector 6 is the same as that of IDT5. The antenna reflector 6 is connected to the bonding pad 8 of an earth wire public-funds thin film via the aluminum pattern 7, respectively. Depending on a use, the antenna reflector 6 may become unnecessary. Although the shape of IDT5 and arrangement are various and there are some variations by the purpose of use, the composition of other surface acoustic wave apparatus is also the fundamentally same structure as drawing 2.

[0003]

[Problem(s) to be Solved by the Invention]However, the following technical problems occurred in the conventional surface acoustic wave apparatus. Generally, various surface acoustic wave apparatus are designed function in a specific frequency band. Center frequency F_c of the frequency band is decided by the pitch of the electrode fingers 5a and 5b, i.e., the interval, and thickness between electrode fingers, and the propagation rate of SAW on the piezoelectric board 1. If the kinds (for example, $LiTaO_3$, $LiNbO_3$, crystal, etc.) of piezoelectric board 1 and the construction material of IDT5 to be used are decided, it will be decided automatically about that the thickness will also be an inter-electrode interval. In a manufacturing process, since the interval of the electrode fingers 5a and 5b of these IDT(s)5 is decided ahead of thickness, it becomes the thickness of each IDT5 to influence center frequency F_c eventually. If the thickness of IDT5 becomes thicker than a designed value, the propagation rate of SAW will become slow and center frequency F_c will move to the low-pass side. Conversely, if it becomes thinner than a designed value, the propagation rate of SAW will become quick and center frequency F_c will move to the high region side. Therefore, in order to obtain desired center frequency F_c, it is started how the thickness of IDT5 can be formed correctly.

[0004]In the conventional surface acoustic wave apparatus, IDT5 is formed in most cases by vacuum evaporation. It may be formed by sputtering. The direction of membraneous quality which formed IDT5 by vacuum evaporation is better for the top where the accuracy of thickness is high than forming by sputtering. Now, the thing highly efficient among the vacuum evaporation machines which have appeared on the market in the commercial scene can form IDT5 in about 5% of accuracy. For example, when forming IDT5 which made the charge of a principal member aluminum on the piezoelectric board 1 of $LiTaO_3$ of 36-degreeYXcut, even if it uses the evaporation apparatus, desired center frequency F_c is obtained only for a surface acoustic wave apparatus with a center frequency of 835**2 MHz to 835 MHz. When this accuracy is permitted, it is good, but when that is not right, it is necessary to adjust a frequency characteristic. There are two kinds of methods in the adjustment method of a frequency characteristic fundamentally. That is, adjustment of a frequency characteristic is performed by

the method used when the method used when center frequency F_c is moving to low-pass, or center frequency F_c is moving to the high region.

[0005]Since the thickness of IDT5 is thicker than a designed value when center frequency F_c is moving to low-pass, thickness is reduced little by little by dry etching, and center frequency F_c is adjusted to a desired value. Since the thickness of IDT5 is thinner than a designed value when center frequency F_c is moving to the high region, for example, SiO_2 and ZnO of an insulator layer are first deposited a little in sputtering etc. on IDT5 at a thick eye. And by dry etching or wet etching, the insulator layer is shaved and center frequency F_c is adjusted to a desired value. However, since the etch rate is quick in the case of wet etching, cautions that IDT5 is not etched are required. Anyway, the adjustment method of these two kinds of frequency characteristics took time and effort and time, and the rise of the cost of a surface acoustic wave apparatus was not avoided.

[0006]

[Means for Solving the Problem]In a surface acoustic wave apparatus provided with IDT which excites SAW based on a high frequency signal which was formed in the shape of a blind on a piezoelectric board, and was given in order that the 1st invention might solve an aforementioned problem, An insulator layer deposited on said IDT and a thin film of a ferromagnetic which is formed on said insulator layer and has predetermined remnant magnetization and coercive force are provided. A board of a ferromagnetic in which the 2nd invention has predetermined remnant magnetization and coercive force for a surface acoustic wave apparatus in the 1st invention, As it carries on a film or a stem, and said board, a film, or a thin film of a stem and said ferromagnetic is permanent-magnet-ized, applying a vertical static magnetic field to a piezoelectric board and surface pressure of said piezoelectric board is made regularity, frequency characteristic adjustment of a surface acoustic wave apparatus is performed. The 3rd invention forms in said piezoelectric board bottom of a surface acoustic wave apparatus of the 1st invention a thin film of a ferromagnetic which has predetermined remnant magnetization and coercive force. Frequency characteristic adjustment of a surface acoustic wave apparatus is performed by the 4th invention applying a vertical static magnetic field to a piezoelectric board of a surface acoustic wave apparatus of the 3rd invention, permanent-magnet-izing a thin film of a ferromagnetic of the upper and lower sides of said piezoelectric board, and making surface pressure of said piezoelectric board regularity.

[0007]The 5th invention was formed in the shape of a blind on a piezoelectric board, was formed on an insulator layer deposited on said IDT in a surface acoustic wave apparatus provided with IDT which excites SAW based on a given high frequency signal, and said insulator layer, and has provided remnant magnetization and a thin film of a ferromagnetic

without coercive force. A board of a ferromagnetic in which the 6th invention does not have remnant magnetization and coercive force in a surface acoustic wave apparatus of the 5th invention, Said board, a film, or a thin film of a stem and said ferromagnetic is magnetized carrying on a film or a stem and applying a vertical variable static magnetic field to said piezoelectric board, surface pressure of said piezoelectric board is adjusted, and frequency characteristic adjustment of a surface acoustic wave apparatus is performed. The 7th invention forms a thin film of a ferromagnetic which does not have remnant magnetization and coercive force in said piezoelectric board bottom of a surface acoustic wave apparatus of the 5th invention. The 8th invention applies a vertical variable static magnetic field to a piezoelectric board of a surface acoustic wave apparatus of the 7th invention, magnetizes a thin film of a ferromagnetic of the upper and lower sides of said piezoelectric board, adjusts surface pressure of said piezoelectric board, and is made to perform frequency characteristic adjustment of a surface acoustic wave apparatus.

[0008]

[Function]Center frequency F_c which is the frequency characteristic of a surface acoustic wave apparatus will move to the low-pass side, if the thickness of IDT becomes thicker than a designed value, and if it becomes thin, it will move to the high region side. Movement is carried out because [of center frequency F_c etc.] the propagation rate of SAW excited by IDT changes. That is, if the thickness of IDT becomes thick, the surface pressure of a piezoelectric board will increase, the propagation rate of SAW will become slow, and center frequency F_c etc. will move to the low-pass side in inverse proportion to the propagation rate of SAW. Similarly, if the thickness of IDT becomes thin, the surface pressure of a piezoelectric board will decrease, the propagation rate of SAW will become quick, and center frequency F_c etc. will move to the high region side. If it puts in another way, influence center frequency F_c of a surface acoustic wave apparatus, etc., but the surface pressure of the field which SAW in a piezoelectric board spreads will not be an overstatement. A surface acoustic wave apparatus and its frequency characteristic adjustment method consist of the 1st - the 4th invention as mentioned above.

Therefore, the thin film of the ferromagnetic formed via the insulator layer on IDT has remnant magnetization and coercive force.

Therefore, the thin film of a ferromagnetic is permanent-magnet-ized by applying a vertical static magnetic field to a piezoelectric board. The surface pressure of a surface acoustic wave apparatus increases by the magnetic attraction between the thin films of the ferromagnetic formed in the thin film of this permanent-magnet-ized ferromagnetic, the board of the ferromagnetic carrying a surface acoustic wave apparatus and a film, a stem, or the piezoelectric board bottom. Since the thin film of the ferromagnetic is permanent-magnet-ized,

even after releasing from a static magnetic field, the surface pressure becomes always fixed. That is, depending on how to apply a static magnetic field, center frequency F_c of a surface acoustic wave apparatus can be made into a desired value, and the value is always kept constant. According to the 5th - the 8th invention, the thin film of the ferromagnetic formed in the thin film of the ferromagnetic formed via the insulator layer on IDT, the board of the ferromagnetic carrying a surface acoustic wave apparatus and a film, a stem, or the piezoelectric board bottom is magnetized by applying a vertical variable static magnetic field to a piezoelectric board. The surface pressure of a surface acoustic wave apparatus changes with the magnetic attraction between these. That is, center frequency F_c of a surface acoustic wave apparatus can be changed to any value depending on how to apply a variable static magnetic field. Therefore, said technical problem is solvable.

[0009]

[Example]

Example drawing 1 [of ** a 1st] (1) - (3) is structural drawing of a surface acoustic wave resonator showing the 1st example of this invention.

As for the figure (1), the A-A sectional view of the figure (1) and the figure (3) of a plan and the figure (2) are expanded sectional views.

This surface acoustic wave apparatus is a surface acoustic wave resonator, and construction material has the piezoelectric board 11 which comprised $LiTaO_3$, $LiNbO_3$, etc. On the piezoelectric board 11, the underlay 12 of the thin film which makes aluminum or aluminum the charge of a principal member is formed, and the input terminal 13 and the output terminal 14 are formed on the underlay 12. The input terminal 13 and the output terminal 14 are the bonding pads of a golden thin film. The input terminal 13 and the output terminal 14 are connected to IDT15 for blind-like excitation [SAW] via the underlay 12, respectively. The thickness and construction material of IDT15 are the same as the underlay 12. The antenna reflector 16 is formed in the both sides of IDT15. The antenna reflector 16 is also produced simultaneously with IDT15, and that of the thickness and construction material of the antenna reflector 16 is the same as that of IDT15. Each antenna reflector 16 is connected to the bonding pad 18 of an earth wire public-funds thin film via the aluminum pattern 17, respectively.

[0010]The dielectric membrane or the piezo electric crystal thin film used as the insulator layer 20 is formed between the electrode fingers of IDT15, and in the upper part as shown in (2) of drawing 1, and (3). The thin film 21 of the ferromagnetic is formed in the upper part of the insulator layer 20. IDT15 and a ground, and the thin film 21 are perfect independently electrically. Although there are various kinds of ferromagnetics, what is hard to corrode and does not apply the surface pressure which it is low-density and does not need it to IDT as a

selection condition of the material of the thin film 21 is suitable. Ferromagnetics, such as pure nickel (nickel), cobalt (Co), an alloy that makes these metal the charge of a principal member, or an alloy which makes iron (Fe) the charge of a principal member, are one of the things applicable to this selection condition, for example. The ferromagnetic is described briefly [the following literature]. Hard iron (Hard iron) and soft iron (Softiron) are in the ferromagnetic which makes Fe the charge of a principal member. The remnant magnetization and coercive force in hard iron are large, the remnant magnetization and coercive force of soft iron are zero, and hysteresis loss hardly exists. The magnetic property of the ferromagnetic of a nickel or Co system also bears a strong resemblance to hard iron. In this example, the alloy which makes nickel the charge of a principal member is used as a material of the thin film 21.
Literature; **** Shigeo work, "electricity-and-magnetism" (Showa 52) Shokodo, and P.232
drawing 3 are the sectional views showing the manufacturing process of drawing 1.
The manufacturing process of a surface acoustic wave resonator is explained referring to this figure.

[0011]In the 1st step, the underlay 12 in drawing 1, IDT15, the antenna reflector 16, and the pattern 17 are formed and formed on the piezoelectric board 11. The standard thickness of these films may be 1000 A, for example. In the 2nd step, the resist 22 is applied on the whole surface on the piezoelectric board 11 by which the underlay 12, IDT15, the antenna reflector 16, and the pattern 17 were formed. At the 3rd step, it exposes through the mask pattern 23. A pattern is formed by removing unnecessary resist at the 4th step. Then, at the 5th step, for example, SiO_2 of the insulator layer 20, ZnO, or Si_3N_4 is deposited on the sample obtained at the 4th step. The thickness of the insulator layer 20 is about about 1.5 to 2.0 times of IDT15. Sputtering process may be sufficient as the method for film deposition of this insulator layer 20. In the 6th step, the film 21 of the ferromagnetic of a Ni alloy is laminated by vacuum evaporation or sputtering process on the insulator layer 20. In the 7th following step, the insulator layer 20 and the film 21 of the ferromagnetic on it can be formed only in the upper part of IDT15 by removing the pattern of the unnecessary resist 22, the unnecessary insulator layer 20, and the film 21 of an unnecessary ferromagnetic by a lift off. The input terminal 13, the output terminal 14, the bonding pad for earth wires, etc. are formed after the 7th step.
[0012]The structure of the surface acoustic wave resonator of drawing 1 is completed by the above process. Here, center frequency F_c of a surface acoustic wave resonator adjusts to a desired value by the following method, when a twist is also high. When the chip of a surface acoustic wave resonator is mounted in a package, the metal thin film or metal plate of an underlay is required also in a common package in the package for independent. In this example which adjusts center frequency F_c of a surface acoustic wave resonator, it is

necessary to use the ferromagnetic of hard iron and similar character for the metal thin film or metal plate. And the area should be just larger than the chip of a surface acoustic wave resonator. Hereafter, this metal membrane or metal plate is called ferromagnetic material layers B.

[0013]Drawing 4 is a schematic illustration showing the magnetization work of drawing 1. If the magnetic pole of the electromagnet 30 is used for the ferromagnetic material layers B and the thin film 21 of the ferromagnetic on IDT15 and a vertical static magnetic field like drawing 4 is applied, static magnetism power will work between the ferromagnetic material layers B and the thin film 21 of a ferromagnetic, and it will come to pay well mutually. The strength of the static magnetic field between the magnetic poles of the electromagnet 30 can be adjusted electrically. Both the magnetic poles of the electromagnet 30 are arbitrary, and another side is the south pole if one of the two is a n pole. By applying a static magnetic field, the thin film 21 and the ferromagnetic material layers B are magnetized, respectively. Therefore, the magnetic pole of the electromagnet 30 is kept away and powerful remnant magnetization remains in a peach, the thin film 21, and the ferromagnetic material layers B, and it becomes a permanent magnet unless it has powerful magnetic effect from the outside. If magnetized like drawing 4, in the field by the side of the south pole and the piezoelectric board 11, the surface of the thin film 21 of a ferromagnetic will become a n pole. On the other hand, in the south pole and the lower surface, the piezoelectric board 11 side of the ferromagnetic material layers B becomes a n pole. Therefore, among both permanent magnets, the magnetic field of about 1 appearance will be made except for an end, and fixed surface pressure will be applied to IDT15. That is, the same effect is acquired as the thickness of IDT15 increased.

[0014]Drawing 5 (1) and (2) is a figure showing the surface acoustic wave resonator of drawing 1 carried in the stem, the figure (1) is a top view and the figure (2) is an A-A sectional view of the figure (1). The chip of a surface acoustic wave resonator is carried in the stem 40. The stem 40 has the input terminal 41 and the output terminal 42. Each terminals 41 and 42 are surrounded with the glass 43, and are insulated with the main part of the stem 40. The input terminal 41 is connected to the input terminal 13 of a surface acoustic wave resonator by the bonding wire 44, and the output terminal 42 is connected to the output terminal 14 of a surface acoustic wave resonator by the bonding wire 45. On the other hand, the bonding pad 18 for earth wires of a surface acoustic wave resonator is connected to the main part of the stem 40 by the bonding wire 46, and the grounding terminal 47 formed in the main part of the stem 40 is drawn outside. The upper part of the stem 40 is the structure where cover with the metaled lid 48 and the chip of a surface acoustic wave resonator is sealed. The material of the stem 40 is a ferromagnetic.

It can use as the ferromagnetic material layers B in the above-mentioned magnetization.

The metaled lid 48 is also formed with the ferromagnetic.

[0015]Next, operation of the surface acoustic wave resonator shown in drawing 1 and drawing 5 is explained. If a not less than several MHz high frequency signal is inputted into the input terminal 13 via the input terminal 41, high frequency voltage will be built over the electrode finger 15a electrically connected to this input terminal 13. Although high frequency voltage occurs inductively in the electrode finger 15b which adjoined the electrode finger 15a and was connected to the output terminal 14 at this time, since it is topologicaly behind, potential difference arises between the input terminal 13 and the output terminal 14. By this, the surface of the piezoelectric board 11 under an electrode finger is distorted, and SAW of the same frequency as an input signal excites. Combination of the electrode finger 15a and the electrode finger 15b becomes strong further by excitation of SAW, and the high frequency signal of a certain zone is outputted from the output terminal 14. It is already said that the zone of the high frequency signal outputted from the output terminal 14 is influenced by the propagation rate of excited SAW. The importance of this example is controlling the propagation rate of SAW magnetically. If the pressure of the surface which SAW of the piezoelectric board 11 spreads increases, the propagation rate of this SAW will fall and center frequency F_c of a surface acoustic wave apparatus will move it to the low-pass side. Although this surface pressure was conventionally controlled by selection of the material which forms the thickness of IDT, or IDT, at this example, by the magnetic attraction between the magnetized ferromagnetic material layers B which sandwich a surface acoustic wave resonator, and the thin film 21 of a ferromagnetic, the pressure was applied to the surface of the piezoelectric board 11, and desired center frequency F_c has been obtained. What is necessary is just to control the strength of the static magnetic field of the electromagnet 30 at the time of making the ferromagnetic material layers B and the thin film 21 of a ferromagnetic magnetize, in order to make center frequency F_c into a desired value. That is, since it asks for the strength of the required static magnetic field experimentally, the strength of a suitable static magnetic field is obtained by controlling the current which flows into the coil of the electromagnet 30. As a result, since the ferromagnetic material layers B and the thin film 21 of a ferromagnetic serve as a permanent magnet, the always stable surface pressure is continuously put on the surface of the piezoelectric board 11, and as for the value of center frequency F_c, as long as there is no magnetic effect from the outside, they are stabilized in a desired value.

[0016]As mentioned above, then, since the propagation rate of SAW is magnetically controlled to this example, it has an advantage that center frequency F_c of a surface acoustic wave resonator can be tuned finely continuously. Drawing 6 (1) and (2) is a figure showing the frequency characteristic of the surface acoustic wave resonator of drawing 1.

A change of the frequency characteristic according [the figure (2)] to static magnetism power according [the figure (1)] to the relation between static magnetism power and center

frequency is shown.
When the static magnetism power M committed between the thin film 21 of a ferromagnetic and the ferromagnetic material layers B is zero, the value of center frequency F_c of a surface acoustic wave resonator is F_0. Center frequency is F_0 before applying a static magnetic field to a surface acoustic wave resonator. F_1 in drawing 6 (1) is the center frequency of a request of center frequency F_c, and M_1 is a value of the static magnetism power M at that time. If the static magnetism power M is raised continuously, center frequency F_c will fall continuously. However, since the thin film 21 and the ferromagnetic material layers B of a ferromagnetic consist of ferromagnetics of hard iron and similar character, remnant magnetization does not fall simply. Therefore, when applying a static magnetic field, it is necessary to apply too much and to be cautious of the contents. Drawing 6 (2) shows the frequency characteristic of the insertion loss of a surface acoustic wave resonator. The frequency characteristic of the surface acoustic wave resonator before applying the static magnetism power M is the characteristic curve 50.
Center frequency is F_0.
If static magnetism power M_1 is applied, a frequency characteristic will become like the characteristic curve 51, and center frequency will serve as F_1. The more the static magnetism power M to apply becomes high theoretically, the more center frequency F_c falls. However, there is a saturation value in remnant magnetization, and it is meaningless even if it applies the static magnetism power M more than fixed. Since the saturation value of the remnant magnetization changes with materials of a ferromagnetic, when it needs powerful static magnetism power, it should just select what has a high saturation value.
[0017]Here, by drawing 6 (1) and (2), desired center frequency F_c must manufacture a surface acoustic wave resonator so that it may become below center frequency F_0 in case the static magnetism power M is certainly zero, so that it may be shown. That is, the reverse cannot be performed although center frequency F_c can be made lower than center frequency F_0 by the static magnetism power M. Therefore, in consideration of the membrane formation accuracy of a vacuum evaporation machine, when forming IDT15 by vacuum evaporation, for example, it is necessary to form membranes so that more highly than the value of center frequency F_1 of a request of center frequency F_0. The more center frequency F_0 is close to center frequency F_1, static magnetism power M_1 is low and, the more ends. That is, although it is necessary to apply a static magnetic field in this example, it is possible to adjust certainly center frequency

F_c of a surface acoustic wave resonator to desired value F_1, and the flexibility and the manufacturing yield of a design are improved greatly. It is dramatically effective in especially the surface acoustic wave resonator that needs highly precise center frequency. Since the surface acoustic wave resonator of this example is mounted in the package of a ferromagnetic, a package plays the role of a magnetic seal and is protected from the magnetic adverse effect from the outside.

[0018]The 2nd example this example constitutes the stem 40 equivalent to the thin film 21 of the ferromagnetic in drawing 1 and drawing 4, and the ferromagnetic material layers B from a ferromagnetic which does not have remnant magnetization and coercive force like soft iron, and others are the surface acoustic wave resonators of the same composition of the 1st example. That is, only when a static magnetic field is applied, the thin film 21 and the ferromagnetic material layers B of a ferromagnetic pay well by the magnetic attraction, and it has composition which the surface pressure of the piezoelectric board 11 increases. If it releases from a static magnetic field, the surface pressure of the piezoelectric board 11 will return to the original value. Drawing 7 (1) and (2) is a figure showing the frequency characteristic of the surface acoustic wave resonator of the 2nd example of this invention. The frequency characteristic adjustment method of the surface acoustic wave resonator of the 2nd example is explained referring to this figure.

The cycle T of drawing 7 as shown in (1), a vertical static magnetic field is applied to the piezoelectric board 11. When the time t is 0 and T_1 ($0<t<T_1$), a static magnetic field is 0 and the time t is T_1 and T_2 ($T_1<t<T_2$), a static magnetic field Namely, M_1, When the time t is T_2 and T_3 ($T_2<t<T_3$), a static magnetic field is M_2. applying such a static magnetic field -- the frequency characteristic of the insertion loss of a surface acoustic wave resonator -- (2) of drawing 7 -- it becomes like. That is, center frequency F_c of a surface acoustic wave resonator changes with the values of a static magnetic field. The frequency characteristic [time / t] between 0 and T_1 ($0<t<T_1$) serves as the characteristic curve 70, and center frequency is set to F0. The frequency characteristic [time / t] between T_1 and T_2 ($T_1<t<T_2$) serves as the characteristic curve 71, and center frequency serves as F_1. A frequency characteristic in case the time t is between T_2 and T_3 ($T_2<t<T_3$) serves as the characteristic curve 72, and center frequency serves as F_2. As mentioned above, in this example, it is possible to give various frequency characteristics to one surface acoustic wave resonator by controlling a static magnetic field. If the given static magnetic field is erased, it can return to an early frequency characteristic.

[0019]This invention is not limited to the above-mentioned example, but various modification

and application are possible for it. As the modification and an application, there is the following, for example.

(i) Although the 1st and 2nd example shows the example of the surface acoustic wave resonator, this invention can adjust the frequency characteristic of all the surface acoustic wave apparatus which have IDT. Therefore, when a band-pass filter is constituted especially using a surface acoustic wave resonator, it becomes easy to often put the accuracy of the resonance frequency and antiresonant frequency of surface acoustic wave resonators together. It is also possible to expand or narrow bandwidth of a band-pass filter by controlling resonance frequency and antiresonant frequency.

(ii) In the surface acoustic wave common machine, the surface acoustic wave filter for transmission and the surface acoustic wave filter for reception in which a branch circuit and a frequency band adjoin are used. It is mutually separated from about 30 MHz of center frequency F_c of each surface acoustic wave filter. Here, if an adjustment method of center frequency which was explained in the 2nd example is used, the unnecessary surface acoustic wave common machine of a branch circuit can consist of only a surface acoustic wave filter for transmission, and a surface acoustic wave filter for reception. Namely, when the surface acoustic wave filter for transmission operates normally, center frequency F_{c1} of the surface acoustic wave filter for reception is moved to the direction which does not have an adverse effect on this surface acoustic wave filter for transmission, On the contrary, when the surface acoustic wave filter for reception operates normally, center frequency F_{c2} of the surface acoustic wave filter for transmission is moved. A branch circuit becomes unnecessary by doing in this way, and a low-loss surface acoustic wave common machine can consist of cases where a branch circuit is used.

[0020](iii) Although the portion equivalent to the ferromagnetic material layers B is set as the stem 40 in the 1st and 2nd example, form the thin film of the ferromagnetic in the piezoelectric board 11 bottom, and it is good also as composition which makes it the film B of a ferromagnetic. In this case, the flexibility of selection of stem construction material goes up.

(iv) Although both the thin film 21 of a ferromagnetic and the ferromagnetic material layers B are permanent-magnet-ized and the magnetic attraction is strengthened in the 1st example, if there are some as which the material of a ferromagnetic may be sufficient, the effect same also as composition as the 1st example of giving remnant magnetization and ******** only to the thin film 21 of a ferromagnetic is expectable.

[0021]

[Effect of the Invention]As explained to details above, in the 1st - the 4th invention, an insulator layer, remnant magnetization, and the thin film of the ferromagnetic with coercive force are provided on IDT.

Therefore, the thin film of a ferromagnetic is permanent-magnet-ized by applying a static magnetic field.
By the magnetic attraction between the thin films of the ferromagnetic formed in the thin film of this permanent-magnet-ized ferromagnetic, the board of the ferromagnetic carrying a surface acoustic wave apparatus and a film, a stem, or the piezoelectric board bottom. The surface pressure of a surface acoustic wave apparatus increases, and center frequency of a surface acoustic wave apparatus can be made into a desired value. Since the thin film of the ferromagnetic is permanent-magnet-ized, even after releasing from a static magnetic field, it comes out to make center frequency of a surface acoustic wave apparatus into a desired value. In the 5th - the 8th invention, the thin film of the ferromagnetic without an insulator layer, remnant magnetization, and coercive force is provided on IDT.
Therefore, the thin film of the ferromagnetic formed in the thin film of the ferromagnetic formed via the insulator layer on IDT, the board of the ferromagnetic carrying a surface acoustic wave apparatus and a film, a stem, or the piezoelectric board bottom is magnetized by applying a variable magnetic field.
The surface pressure of a surface acoustic wave apparatus changes with the magnetic attraction between these. That is, the center frequency of a surface acoustic wave apparatus can be changed to any value depending on how to apply a variable static magnetic field.

[Translation done.]